

1 Improvements in or Relating to Internal Combustion
2 Engines

3

4 This invention relates to improvements in or
5 relating to internal combustion engines, and in
6 particular, but not exclusively, to improvements
7 relating to replacement apparatus for the intake and
8 exhaust valves of internal combustion engines.

9

10 Conventional four stroke internal combustion engines
11 involve a four stage cycle. Firstly, there is an
12 intake of air/fuel mixture into a cylinder; known as
13 "intake stroke". Secondly, a piston within the
14 cylinder compresses the air/fuel mixture; known as
15 "compression stroke". Thirdly, the compressed
16 air/fuel mixture is ignited in the cylinder causing
17 combustion; known as "combustion stroke". And
18 lastly, the combusted gases are exhausted; known as
19 "exhaust stroke".

20

21 A four stroke internal combustion engine comprises
22 an intake valve to allow an ingress of air/fuel

1 mixture into a cylinder, and an exhaust valve, to
2 allow an egress of exhausted gases after combustion
3 of the air/fuel mixture.

4

5 The timing of the opening and closing of the valves
6 is vital to an engines performance.

7

8 To allow the piston to draw-in the fuel/air mixture
9 (or air alone in the case of a direct injection
10 engine), the intake valve needs to open as the
11 piston moves from an extended position to a
12 retracted position on the intake stroke.

13

14 The exhaust valve needs to be opened as the piston
15 is extended in the exhaust stroke.

16

17 Both the intake and the exhaust valves each comprise
18 a rocker arm and a valve return spring, with the
19 rocker arm being actuated by a cam or a lobe located
20 on a camshaft.

21

22 The valves act against the valve return springs,
23 where the valves are fired in one direction, only
24 then to stop at the extent of their travel, and be
25 sent flying in the opposite direction. This happens
26 many times a minute which wastefully drains power
27 from the engine. This also causes noise, vibration
28 and harshness.

29

30 As the camshaft rotates, the shape of the cam which
31 actuates the rocker arm, determines the timing of
32 the opening and closing of the intake and exhaust

1 valves.

2

3 Conventional designs of cams, particularly fixed
4 cams, will only operate optimally over a limited
5 range of speeds.

6

7 According to one aspect of the present invention, a
8 cylinder head assembly comprises a cylinder head
9 having an inlet passage and an outlet passage for
10 communication, in use, with a cylinder, and at least
11 one rotatably mounted shaft member interposed
12 between the inlet and outlet passages and the
13 cylinder, the shaft member(s) having passage means
14 to allow an ingress of air mixture from the inlet
15 passage to the cylinder at a first desired
16 rotational position, and to allow an egress of
17 combusted gases from the cylinder through the outlet
18 passage at a second desired rotational position and
19 to prevent the air or combusted gases from entering
20 or exiting the cylinder at a third desired
21 rotational position.

22

23 There may be two shaft members, one cooperating with
24 the inlet passage and one with the outlet passage.

25

26 Preferably, the shaft members are coupled, in use,
27 to a crankshaft with means for independently
28 controlling or adjusting the speed of rotation of
29 said shaft members.

30

31 Alternatively, the shaft members are driven
32 independently of the crankshaft, and of each other,

1 with means for individually controlling or adjusting
2 the speed of rotation of said shaft members.

3

4 The shaft member or each shaft member may be
5 substantially solid, and the passage means may
6 comprise a recess in the shaft member or a
7 respective recess in each of the shaft members.

8

9 Alternatively, each shaft member may be hollow; each
10 shaft member having at least one aperture located
11 around a portion of its circumference, wherein the
12 inlet shaft member allows an ingress of air/fuel
13 mixture through the inlet shaft member to enter said
14 cylinder when the aperture in the inlet shaft is
15 presented to the cylinder, and the outlet shaft
16 member allows an egress of combusted gases to exit
17 the cylinder when the aperture in the outlet shaft
18 member is presented to the cylinder.

19

20 Preferably each shaft member is provided with an
21 inner hollow tube member rotatably mounted within
22 said shaft member; each inner tube member having at
23 least one aperture located around a portion of its
24 circumference; rotation of said inner tube member
25 within the respective hollow shaft members providing
26 a variable size effective aperture, which allows a
27 variable ingress of combustion air to enter said
28 cylinder through the effective aperture in the inlet
29 shaft member, and allows a variable egress of
30 combusted gases from the cylinder to exit through
31 the effective aperture in the outlet shaft member.

1 Preferably also, the speed of rotation of the inner
2 and outer tube members are such that the effective
3 aperture maximises or restricts the rate of ingress
4 of air, or egress of exhaust gases, through the
5 respective inner tube members.

6

7 The inner tube members may be coupled, in use, to a
8 crankshaft with means for independently controlling
9 or adjusting the speed of rotation of said tube
10 members. Alternatively, the tube members may be
11 driven independently of the crankshaft, and of each
12 other, with means for individually controlling or
13 adjusting the speed of rotation of said tube
14 members.

15

16 Typically, the cylinder head assembly will form part
17 of a multi-cylinder engine with the shaft member(s)
18 extending over a number of cylinders, the shaft
19 member(s) having a corresponding number of passage
20 means.

21

22 The shaft member(s) suitably have gas tight seal
23 assemblies.

24

25 From another aspect, the invention provides a method
26 of allowing an ingress and egress of combustion air
27 and combusted gases from a cylinder comprising the
28 steps of:

29 presenting a passage means within a shaft
30 member to an inlet passage;

31 retracting of a piston within a cylinder to
32 allow an induction of air from the inlet passage

1 through said passage means into the cylinder;
2 rotating the shaft member to prevent any
3 leakage of air upon a compression of the air in the
4 cylinder by the piston;
5 combusting air/fuel mixture in the cylinder to
6 cause said piston to retract;
7 extending the piston in the cylinder;
8 presenting passage means to the cylinder and
9 an outlet passage to allow an egress of combusted
10 gases; and
11 repeating the above steps.

12

13 In one form of the method, the same passage means is
14 used for induction and egress.

15

16 The passage means may be formed by an aperture in at
17 least one hollow shaft, and the method further
18 includes the step of varying the effective size of
19 the aperture to restrict or maximise the amount of
20 fluid flow through the aperture.

21

22 Embodiments of the present invention will now be
23 described, by way of example only, with reference to
24 the accompanying drawings in which:-

25

26 Fig. 1 is a schematic front sectional view of a
27 conventional four stroke internal combustion
28 engine;

29

30 Figs. 2a-d are schematic front sectional views
31 illustrating the workings of a single rotatably
32 mounted shaft member of the present invention;

1 Figs. 3a-d are schematic front sectional views
2 illustrating the workings of an alternative
3 embodiment with two rotatably mounted shaft
4 members;

5
6 Figs. 4a and 4b are a side view and perspective
7 side view respectively (shown schematically) of
8 an alternative shaft member;

9
10 Fig. 5 is a schematic plan view of further
11 alternative shaft members;

12
13 Fig. 6 is a schematic plan view of shaft member
14 embodiments applied to more than one cylinder;

15
16 Fig. 7 is a schematic perspective view of
17 apparatus of a first embodiment;

18
19 Fig. 8 is a schematic perspective view of
20 apparatus of a second embodiment; and

21
22 Fig. 9 is a schematic perspective view of
23 apparatus of a third and fourth embodiment;

24
25 With reference to the drawings, and in particular
26 Fig. 1, there is shown conventional apparatus of a
27 four stroke internal combustion engine 10.

28
29 The conventional engine 10 comprises the known
30 element of a cylinder 12 which houses a piston M
31 which is movably sealed therein.

32

1 The piston M is attached to a crankshaft P by a
2 connecting rod N and rod bearing O. The crankshaft
3 P serves to convert the up and down motion of the
4 piston M into rotational motion; which is utilised
5 to turn wheels of a vehicle, propellers of a vessel
6 or aircraft.

7
8 The conventional engine 10 also comprises the known
9 element of a cylinder head D having an intake valve
10 assembly A and an exhaust valve assembly J which are
11 both intermittently actuated by a camshaft I.
12 Both valve assemblies A, J have rocker arms 14, 18
13 with corresponding springs 16, 20, and conventional
14 poppet valves 22, 24.

15
16 On the intake stroke of a four stroke engine 10, the
17 intake valve assembly A is open to allow an ingress
18 of air/fuel mixture into the cylinder 12 via an
19 intake port C.

20
21 Meanwhile, the exhaust valve assembly J is closed.
22 The piston M will retract drawing the air/fuel
23 mixture into the cylinder 12.

24
25 The piston M retracts by virtue of stored energy
26 being transferred from a flywheel (not shown) to the
27 piston M via the crankshaft P.

28
29 It should be understood that on all "non-power
30 strokes", namely, retraction of the piston M on the
31 intake stroke, compression of the air/fuel mixture,
32 and exhausting of the combusted gases, the energy

1 required to drive the piston M is transferred from
2 the flywheel to the connected crankshaft P.

3

4 As the piston M bottoms out it will change direction
5 and extend within the cylinder 12. Closure of the
6 intake valve assembly A allows for the air/fuel
7 mixture to be compressed within the cylinder 12;
8 referred to as "compression stroke".

9

10 Again, the exhaust valve assembly J is closed.

11

12 When fully compressed, a spark plug K extending into
13 the cylinder 12, ignites the compressed mixture to
14 cause combustion.

15

16 Alternatively, in a diesel engine, the heat caused
17 by compressing the air/fuel mixture alone will
18 result in combustion.

19

20 The resultant combustion produces an excess of gases
21 which force the piston M to retract within the
22 cylinder 12.

23

24 The exhaust valve assembly J is opened as the piston
25 M bottoms out to allow an egress of the combusted
26 gases through an exhaust port L; referred to as
27 "exhaust stroke".

28

29 As the piston M returns to an extended position, the
30 exhaust valve assembly J is closed, whereas the
31 intake valve assembly A is open to start the cycle
32 again and allow in ingress of air/fuel mixture.

1 It will be realised that the timing of the opening
2 and closing of the valve assemblies A, J will have a
3 large bearing on the performance of the engine 10.
4 If either of the valve assemblies A, J are open on
5 the compression stroke, then the air/fuel mixture
6 will not be fully compressed resulting in poor
7 performance of the engine 10.

8

9 Lobes or cams 26 located on the camshaft I are
10 designed to intermittently open and close each of
11 the valve assemblies A, J as and when required.

12

13 It will be realised however, that (fixed) cams 26 of
14 a particular design operate optimally for a given
15 range of speeds only.

16

17 The rocker arms 14, 18 act against the corresponding
18 valves 22, 24 and valve return springs 16, 20. The
19 valves 22, 24 are fired in one direction, only then
20 to stop at the extent of their travel, and be sent
21 flying in the opposite direction. This happens many
22 times a minute which wastefully drains power from
23 the engine 10 and can cause noise, vibration and
24 harshness.

25

26 In a first embodiment of the present invention, as
27 illustrated in Figs. 2a-d and Fig. 7, there is
28 provided apparatus 100 in the form of a cylinder
29 head assembly comprising a cylinder head D adapted
30 with a valve assembly replacement shaft member 110
31 rotatably mounted.

32

1 The shaft member 110 is of the form of a cylindrical
2 rod with a recess 112 removed around a portion of
3 the circumference of the shaft member 110 and along
4 that part of its length which is presented to
5 (above) the cylinder 12.

6

7 It is to be understood that the shaft member 110 and
8 recess 112 are presented facing the cylinder
9 irrespective of the cylinder's orientation; for
10 example, it may be a horizontal engine, in which
11 case the recess 112 is presented adjacently facing
12 the cylinder 12.

13

14 The shaft member 110 is rotatably mounted in the
15 cylinder head D.

16

17 The shaft member 110 is parallel with, and is co-
18 operatively driven by, the crankshaft P by virtue of
19 connecting means (not shown) in the form of a belt
20 or gearing 114.

21

22 The recess 112 serves to allow an ingress or egress
23 of air/fuel mixture or exhaust gases to and from the
24 cylinder 12 upon rotation of the shaft member 110.

25

26 The depth and length of the recess 112 presented to
27 (above) the cylinder 12 can be of any design and
28 dimensions to allow optimum ingress and/or egress of
29 air/fuel mixture and/or combusted gases to and from
30 the cylinder 12; for example, the recess 112 may be
31 of uniform depth and length or may have varying

1 depths or lengths, or the recess 112 may also be of
2 the form of a helix, etc.

3

4 In operation, as shown in Fig. 2a and Fig. 7, there
5 is an inlet of air from an inlet manifold 116 which
6 is coupled to a carburettor/fuel injector (not
7 shown) to form an air/fuel mixture.

8

9 The shaft member 110 is presented such that the
10 recess 112 faces the intake port C and the cylinder
11 12 to allow an ingress of air/fuel mixture.

12

13 Rotation of the crankshaft P, initially caused by a
14 starter motor (not shown) then subsequently by the
15 transfer of energy from the flywheel, causes contra-
16 rotation of the shaft member 110 by virtue of
17 contra-connecting means (not shown) being connected
18 to the crankshaft P and gearing 114 on the shaft
19 member 110.

20

21 Rotation of the crankshaft P will cause the piston M
22 to retract, drawing-in the air/fuel mixture through
23 the inlet port C, into the cylinder 12.

24

25 Meanwhile, as the piston M is retracted by virtue of
26 the rotating crankshaft P, the recess 112 of the
27 shaft member 110 will contra-rotate in unison.

28

29 As the piston M bottoms out, the rotating shaft
30 member 110 and recess 112 face the intake port C and
31 the cylinder head D. Thus preventing any ingress or

1 leakage of air/fuel mixture on the compression
2 stroke, as shown in Fig. 2b.

3

4 On the compression stroke, the piston M is extended
5 to compress the air/fuel mixture as the crankshaft P
6 and interconnected shaft member 110 similarly
7 rotate, as shown in Fig. 2c.

8

9 The recess 112 faces the cylinder head D and the
10 exhaust port L.

11

12 A spark plug K (not shown for convenience in Figs.
13 2a-d), ignites the compressed air/fuel mixture in
14 the cylinder 12.

15

16 Alternatively, in a diesel engine, the heat caused
17 by compressing the air/fuel mixture alone will
18 result in combusted gases.

19

20 The resultant combustion causes the piston M to be
21 fired to a retracted position causing the crankshaft
22 P and shaft member 110 to rotate.

23

24 The recess 112 meanwhile, will rotate facing both
25 the exhaust port L and cylinder 12 to allow the
26 piston M to extend exhausting the combusted gases
27 out through the recess 112 into the exhaust port L.

28

29 Upon exhaustion of the combusted gases, rotation of
30 the crankshaft P will cause the recess 112 to rotate
31 and face the cylinder 12 and inlet port C to allow
32 the cycle to begin again.

1 As the rotation of the crankshaft P and shaft member
2 112 are rotating opposite to one another, this will
3 have a balancing effect which may reduce noise and
4 vibration of the engine 10.

5
6 To prevent any unburnt fuel being expelled with the
7 exhaust gases, fuel injectors (not shown) may be
8 used to control the flow of fuel into the separate
9 branches of the inlet manifold. The fuel injectors
10 would be closed before the recess 112 closes, such
11 that no unburnt fuel would be exhausted by being
12 trapped in the recess 112 as the shaft 110 rotates.
13 Alternatively, the fuel injectors may directly
14 inject the fuel into the cylinder 12. Hence, only
15 air would therefore pass through the manifold, via
16 the recess 112 into the cylinder 12, avoiding
17 unburnt fuel being trapped in the recess 112, and
18 being exhausted as the shaft 110 rotates.

19
20 In a second embodiment of the present invention, as
21 shown in Figs. 3a-d and Fig. 8, there is provided
22 apparatus 200 in the form of a cylinder head
23 assembly comprising a cylinder head D having two
24 valve assembly replacement shaft members, namely, an
25 intake shaft member 210 and an exhaust shaft member
26 212 which are rotatably mounted.

27
28 The shaft members 210, 212 are of the form as
29 described above with recesses 214, 216 as also
30 described above.

31

1 The shaft members 210, 212 are rotatably mounted in
2 the cylinder head D as before.

3

4 The shaft members 210, 212 are parallel with, and
5 are co-operatively driven by, the crankshaft P by
6 connecting means (not shown) coupled to gearing 114.

7

8 Alternatively, the shaft may be belt driven from the
9 crankshaft P.

10

11 The recesses 214, 216 are as described above, and
12 serve to allow an ingress of air/fuel mixture and an
13 egress of combusted gases respectively, into the
14 cylinder 12 upon rotation of the crankshaft P and
15 shaft members 210, 212.

16

17 The depth and length of the recesses 214, 216
18 presented to (above) the cylinder 12 can be of any
19 design and dimensions to allow optimum ingress and
20 egress of air/fuel mixture and combusted gases to
21 and from the cylinder 12; for example, the recesses
22 214, 216 may be of uniform depth and length or may
23 have varying depths or lengths, or they may be of
24 the form of a helix, etc.

25

26 In operation, as shown in Fig. 3a, the intake shaft
27 member 210 is rotated, by the crankshaft P, to face
28 the intake port C and the cylinder 12 to allow an
29 ingress of air/fuel mixture.

30

31 Meanwhile, the exhaust shaft member 212 faces the
32 exhaust port L and cylinder head D thus preventing

1 air/fuel mixture to leave the cylinder 12 or air to
2 enter therein.

3

4 As the air/fuel mixture enters the cylinder 12 from
5 the intake port C, the crankshaft P rotates causing
6 the piston M to retract, causing the shaft members
7 210, 212 and hence recesses 214, 216, to rotate in
8 unison by virtue of them being interconnected by
9 connecting means to the gearing 114.

10

11 As the piston M begins to extend, the recess 214
12 rotates to face the cylinder 12 and cylinder head D.
13 Thus preventing any ingress or leakage of air/fuel
14 mixture from the cylinder 12 on the compression
15 stroke, as shown in Fig. 3b.

16

17 Meanwhile, the exhaust shaft member 212 will
18 likewise have rotated with the recess 216 now facing
19 the cylinder head D completely. Thus preventing an
20 ingress of air or an egress of air/fuel mixture.

21

22 On the compression stroke, the crankshaft P rotates
23 causing the piston M to extend compressing the
24 air/fuel mixture. The interconnected shaft members
25 210, 212 and recesses 214, 216 similarly rotate.

26

27 As the piston M becomes fully extended on the
28 compression stroke, the intake recess 214 at this
29 point completely faces the cylinder head D and is
30 thus closed off preventing any egress of compressed
31 air/fuel mixture, as shown in Fig. 3c.

32

1 A spark plug K (not shown for convenience in Figs.
2 3a-d), ignites the compressed air/fuel mixture in
3 the cylinder 12.

4
5 Alternatively, in a diesel engine, the heat caused
6 by compressing the air/fuel mixture alone will
7 result in combustion.

8
9 The resultant combustion causes the piston M to be
10 fired to a retracted position causing the crankshaft
11 P and shaft members 210, 212 to rotate.

12
13 The intake recess 214 will rotate facing both the
14 cylinder head D and the intake port C.

15
16 The exhaust recess 216 will rotate facing the
17 cylinder 12 and exhaust port L to allow an egress of
18 combusted gases, as shown in Fig. 3d.

19
20 The piston M then extends exhausting the combusted
21 gases out through the recess 216 into the exhaust
22 port L by virtue of the rotating crankshaft.

23
24 Meanwhile, rotation of the crankshaft P will cause
25 the intake recess 214 to rotate and face the inlet
26 port C and the cylinder 12 to allow the cycle to
27 begin again.

28
29 The exhaust recess 216 will likewise rotate facing
30 the exhaust port L and the cylinder head D, as shown
31 in Fig. 3a.

32

1 In a third embodiment of the present invention there
- 2 is provided apparatus 400, as shown in Figs. 5 and
3 9, having apparatus 200 as previously described in
4 the second embodiment, wherein the intake shaft
5 member 210 and the exhaust shaft member 212 are of
6 the form of a hollow cylindrical intake shaft member
7 410 and a hollow cylindrical exhaust shaft member
8 412.

9
10 In this way, it should be realised that the heavy
11 intake manifold (not shown) and outlet manifold 116,
12 can be replaced by single, less heavy and
13 complicated manifolds 418, 420, which allow the
14 ingress of air/fuel mixture and egress of combusted
15 gases through the hollow shaft members 410, 412.

16
17 The shaft members 410, 412 are presented to (above)
18 the cylinder 12 to allow an ingress of air/fuel
19 mixture thereto through aperture 414, and an egress
20 of exhaust gases therefrom through aperture 416.

21
22 In this third embodiment, the air/fuel mixture
23 passes through the hollow intake shaft member 410
24 and exits through the aperture 414 into the cylinder
25 12.

26
27 After the compression and combustion strokes, the
28 exhaust gases exit the cylinder 12 through the
29 aperture 416 and leave via the hollow exhaust shaft
30 member 412.

31
32 The shaft members 410, 412 are connected to the

1 crankshaft P by connection means (not shown) coupled
2 to gearing 114.

3

4 Alternatively, the shaft members 410, 412 may be
5 coupled to the crankshaft P by a belt.

6

7 It is conceived that rotation of the shaft members
8 410, 412 although specifically described as being
9 coupled to and controlled by the crankshaft P, may
10 be independently and controllably adjustable.

11

12 Furthermore, both shaft members 410, 412 may be
13 driven independently of the crankshaft P and of each
14 other.

15

16 In a fourth embodiment of the present invention,
17 there is provided apparatus 200 wherein the shaft
18 members 210, 212 are of the form of hollow shaft
19 members 300, as shown in Figs. 4a and 4b.

20 Each shaft member 300 has an inner hollow
21 cylindrical tube 310, rotatably mounted within an
22 outer hollow cylindrical tube 312, also rotatably
23 mounted.

24

25 The tubes 310, 312 have apertures 314, 316 which
26 correspondingly serve to allow an ingress of
27 air/fuel mixture and egress of exhaust gases to pass
28 therethrough.

29

30 The apertures 314, 316, when appropriately aligned,
31 form a passage 326.

32

1 The area of the passage 326 is adjusted and
2 controlled by the speed of rotation of the tubes
3 310, 312 relative to one another.

4
5 Rotation of the tubes 310, 312 is controlled by
6 gears 318, 320 located around the circumference of
7 respective cylindrical buttressed ends 322, 324 of
8 the tubes 310, 312.

9
10 Rotation of the tubes 310, 312 may be coupled to the
11 crankshaft P with independently controllable/
12 adjustable means for varying the speed of rotation
13 of the tubes 310, 312.

14
15 Alternatively, both tubes 310, 312 may be driven
16 independently of the crankshaft P and of each other,
17 with controllable/ adjustable means for varying the
18 speed of rotation of the tubes 310, 312.

19
20 It will be recognised that the tubes 310, 312 may
21 also be belt driven or the like, independently of,
22 or coupled to, the crankshaft P.

23
24 The speed of rotation of the inner tube 310,
25 relative to the outer tube 312, is such that the
26 area of the passage 326 maximises or restricts the
27 rate of ingress or egress of air/fuel mixture or
28 exhaust gases. In this way, the rotatable shaft
29 members 300 offer a variable valve timing and
30 variable valve size.

31
32 With reference to Figs. 4a and 4b, it is to be

1 understood that both tubes 310, 312 do not move
2 horizontally/longitudinally. The apertures 314, 316
3 share a common centre-line C/L, and are shown offset
4 for illustrative purposes only.

5
6 Common to all embodiments and with regard to sealing
7 of the various shaft members 110, 210, 212, 310,
8 312, 410, 412 of the present invention, these will
9 be as tight a fit as possible cognisant of the
10 expansion of materials of the individual,
11 respective, components that will occur once the
12 engine reaches working temperature.

13
14 The shaft members 110, 210, 212, 310, 312, 410, 412
15 include gas tight seals (not shown) incorporated on
16 the outside faces of bearing races (not shown), of
17 support bearings (not shown), that will be spaced
18 along the rotating shaft members 110, 210, 212, 310,
19 312, 410, 412 between the cylinder 12.

20
21 Gas tight paddles (not shown) are located within
22 apertures (not shown) of the shaft members 110, 210,
23 212, 310, 312, 410, 412, at either side of the
24 respective recesses and apertures 112, 214, 216,
25 314, 316, 414, 416, of the axis of rotation.

26
27 Springs (not shown) are located at the base of the
28 paddles within the apertures. These serve to force
29 the paddles outwards towards and against the inside
30 surfaces of the cylinder head D, within which the
31 shaft members rotate, so ensuring a gas tight seal
32 in a similar way to the WANKEL rotary engine.

1 Common to all embodiments, it should be realised
2 that the shaft members 110, 210, 212, 310, 312, 410,
3 412 may be of the form of extended or adapted shaft
4 members 510, 512, rotatably mounted, with a
5 plurality of recesses or apertures 514, 516
6 corresponding to the number of cylinders 12, as
7 shown in Fig. 6.

8
9 Furthermore, the recesses 112, 214, 216 and
10 apertures 314, 316, 414, 416 of the corresponding
11 shaft members 110, 210, 212, 310, 312, 410, 412 can
12 be as wide as the diameter of the cylinder 12 above
13 which they sit. This means that a far greater area
14 will be available for an ingress of air/fuel mixture
15 or egress of exhausted gases, than might be
16 associated with conventional valves.

17
18 The hollow intake shaft members (310, 312,) 410, 510
19 may form an integral part of an inlet system (not
20 shown), or may feed into, much simplified, single
21 branch manifolds 418, at the respective open end of
22 the shaft members (310, 312), 410, 510 at an end of
23 the cylinder head D.

24
25 The hollow exhaust shaft members (310, 312), 412,
26 512 may form an integral part of an exhaust system
27 (not shown), or may feed into, much simplified,
28 single branch manifolds 420, at respective open ends
29 of the shaft members (310, 312), 412, 512 at an end
30 of the cylinder head D.

31
32 In this way, the air/fuel mixture and exhaust gases

1 would not be required to travel via individual
2 openings within the cylinder head D to individual,
3 heavy, complicated, and expensive multiple branches
4 of intake/exhaust manifolds, feeding the
5 intake/exhaust ports C, L to each cylinder 12.

6

7 The present invention as described, has a reduced
8 size compared to a conventional engine 10 and offers
9 greater flexibility to the location, installation,
10 and utilisation of internal combustion engines.

11

12 The simpler design will have favourable implications
13 as to complexity, overall size of the engine,
14 efficiency, noise and reliability, finance of raw
15 materials, manufacturing, etc.

16

17 For the sake of clarity, it should be understood
18 that fuel injectors/carburettors, and the spark
19 plug, have been omitted from Figs. 2a-d and 3a-d but
20 may be part of the cylinder head assembly.

21

22 The foregoing description refers to the induction of
23 air/fuel mixture, as will be the case where a
24 carburettor or manifold fuel injection is used. It
25 will be appreciated that the invention may equally
26 be applied to direct fuel injection engines, in
27 which case the induction will be of charge air
28 without fuel.

29

30 Modifications and improvements may be made to the
31 above without departing from the scope of the
32 present invention.